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ABSTRACT

The development phases of an operational computer managed instruction (CMI) system include planning, when the instructional model is designed; acquisition, when instructional system specifications are prepared; implementation/operation, which provides for the resolution of operational problems; evaltation, when the system is tested; and refinement, which provides for the improvement of system functioning and capabilities based on evaluation results. Five problems which may impact on the conduct of R&D during any of these phases are noted: (1) few off-the-shelf solutions exist; (2) hardware and software commitments limit R&D solutions; (3) solutions may not be practical; (4) research and operational personnel may not agree on R&D; and (5) research may be incompatible with operational training. A brief description of a joint venture between the Technical Training Command and the Navy Personnel Research and Development Center provides some insight into the problems encountered and the general R&D approach the Navy is using to overcome them. (BBM)

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PROBLEMS IN RESEARCHING COMPUTER MANAGED INSTRUCTION

by

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Problems in Researching Computer Managed Instruction

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I. The involvement of Research and Development (R&D) with CMI systems proceeds along the phases of any developing computer-based educational system. Problems in conducting R&D in the context of an operational CMI system, also vary with the development phases. This paper will first, briefly describe these development phases of an operational CMI system and the associated R&D tasks while focusing on the common R&D problems and secondly, the paper will concretize this necessary mutual relationships between operational training and research by using, as an example, the Navy's CMI system and its R&D program. Table 1 sequentially lists the phases that must be accomplished as an organization proceeds with the objective of developing, implementing, and operating a CMI system. Note that these phases would apply to the development of any computer based instructional system. It should also be understood that these phases in Table 1 would have been preceded by an appropriate needs assessment which would provide conrete justification for the acquisition of a CMI system. The needs assessment should, of course, involve the research community to make sure that the assessment is both adequate and objective. The five phases are self-explanatory and would be tackled to some degree by even the poorest of organizations. But, it is precisely this concern for excellence which calls for the R&D associated with each phase. To the extent that the organization developing the system can not adequately accomplish a phase, the resulting instructional system will suffer.

For the PLAN phase, the R&D consists of constructing the appropriate CMI model. This R&D may be quite extensive and might involve the experimental tryout of a system. During the ACQUIRE phase, the R&D community should continue to provide consulting service to ensure that the hardware, software, and lessonware specifications developed by the operational organization, properly reflect the instructional system specifications generated by the research efforts. It is during the planning and acquisition phases that hardware and computer software decisions are made that inalterably solidify elements of the CMI system. Obviously, if these initial decisions are appropriate then not only will the instructional system work better, but subsequent R&D will also be facilitated.

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TABLE 1

OPERATIONAL CMI SYSTEM DEVELOPMENT PHASES
AND ASSOCIATED R&D TASK AREAS

VELOPMENT PHASE	R&D TASK AREAS
PLAN	- DESIGN INSTRUCTIONAL MODEL.
ACQUIRE	- PREPARE INSTRUCTIONAL SYSTEM SPECIFICATIONS.
PLEMENT/OPERATE	- RESOLVE OPERATIONAL PROBLEMS.
EVALUATE	- CONDUCT SYSTEM EVALUATION.
REFINE	- IMPROVE SYSTEM FUNCTIONING AN CAPABILITIES.

During the IMPLEMENT/OPERATE phase the training organization has primary responsibility, but they encounter many problems which require immediate attention. The R&D at this time is very task or problem oriented. The system operators are desirous of immediate solutions and have little time for prolonged deliberations of a researcher. It is, however, a critical period for the system, in that now that the expensive instructional system is operational many people are looking for evidence of its adequacy. It is of paramount concern that the research world be responsive to the system operators and their problems.

To an extent the operational organization has been sold a bill of goods with the system, and it is encumbent on the researchers to provide the necessary follow-up support to move the system from the conceptual stage to the well-functioning, operational stage. The "operate" R&D is not glamorous but it is necessary. And it does have an exciting component to it. That excitement comes from the fact that many of the problems have never been encountered before, since problems with operational systems are not generally reported in the literature and there is just not adequate experiential background to draw from in solving them. This R&D is pure front-line work with the task being the immediate problem which may seem trivial, but survival of the system make be at stake.

During the EVALUATE phase, the associated R&D will generate the data which indicate how effectively the various components and the CMI system as a whole are operating. During this phase diplomacy is a valuable resource to draw upon during the conduct of evaluation R&D.

As the system matures everyone turns to the task of the REFINE phase, with the mutual intent of making a live enduring system even better. R&D is directed towards making those system changes which improve the effectiveness of the system and expand its capabilities. This R&D is exciting and fun, since all parties can readily see the positive benefits to be derived from good research and are willing to pay the price.

If the reader perceives that as an operational CMI system is conceived, implemented and refined, there are subtle changes in the mutual involvement, motivation, and concern of both the operational educational organization and the R&D group, then I have succeeded in characterizing one of the major problems intrinsic to the conduct of R&D in an operational CMI context.

Table 2 lists five problems which may impact on the conduct of R&D during any of the development phases. First, there are few off-the-shelf, or immediately usable solutions in existence. Solutions are not readily at hand for solving problems involving the instructional model, operational training, use of evaluation techniques, or specific system enhancements. R&D must take available technology and make what changes are necessary to adapt the "solution" to the operational system, or perhaps even develop new technology. The second problem

TABLE 2

OPERATIONAL CMI R&D PROBLEMS

1. FEW OFF-THE-SHELF SOLUTIONS EXIST.

2. HARDWARE AND SOFTWARE COMMITMENTS LIMIT R&D SOLUTIONS.

3. SOLUTIONS MAY NOT BE PRACTICAL.

4. RESEARCH AND OPERATIONAL PERSONNEL MAY NOT AGREE ON R&D.

5. RESEARCH MAY BE INCOMPATIBLE WITH OPERATIONAL TRAINING.

derives from the fact that as the system is specified in terms of hardware and software, constraints are placed on any possible changes. Hence, the system limits the possible solution alternatives to be developed by R&D.

The third problem is that many potential solutions are not practical from the operational perspective. With thousands of students awaiting instruction, an operational system cannot afford the luxury of leisurely retrofitting with exotic techniques or devices which have a high degree of risk.

Fourth, the R&D and the operational communities may not agree with the proposed research in terms of severity of the problem, implementation costs, or a myriad of other factors. Regardless, this disagreement will result in impediments to the conduct of research and the improvement of the instructional system. In fact, this disagreement may be due to problem number five. Namely, the research may be incompatible with operational training. No research project is going to shut down a school, if there is a need for school graduates.

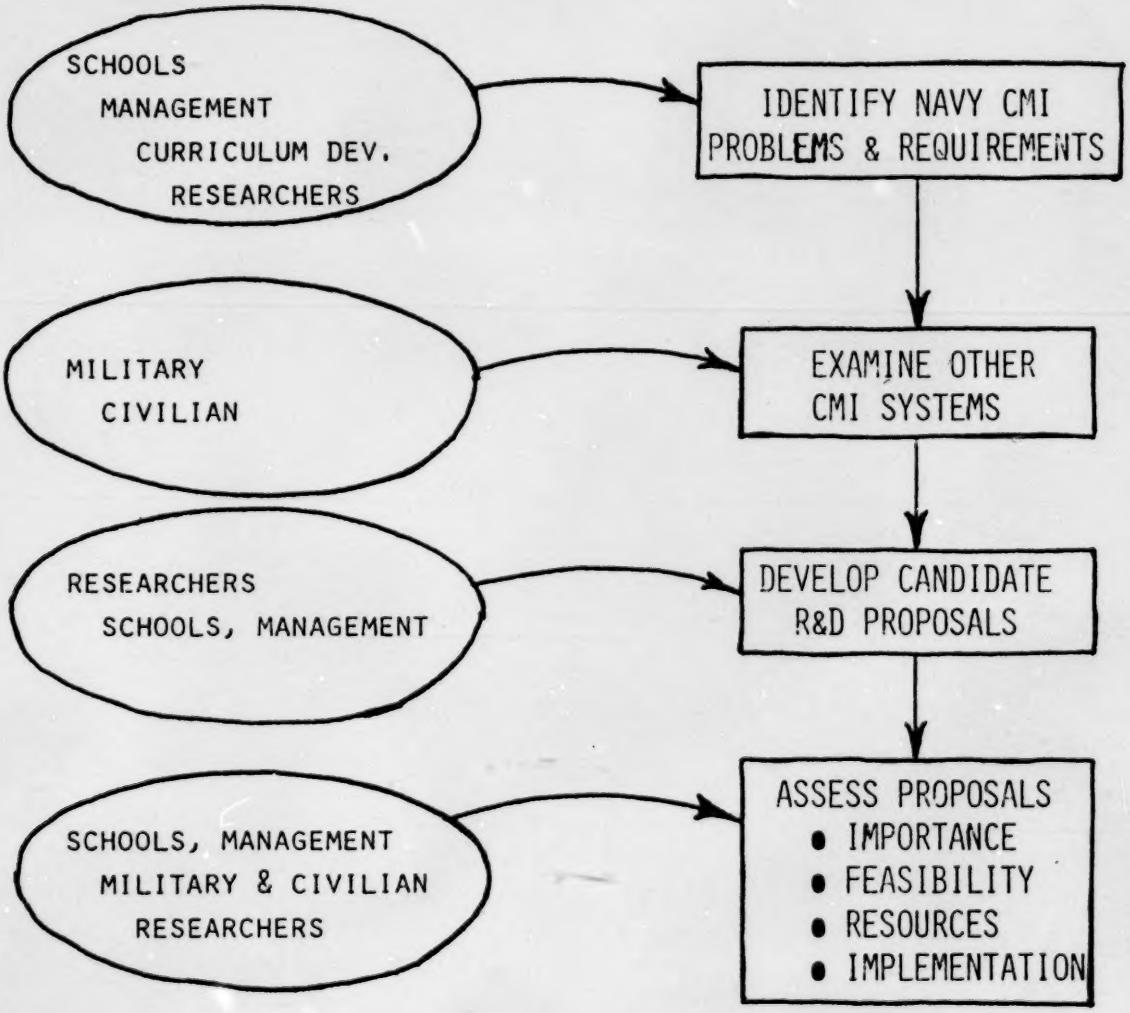
Given these R&D problems, it is possible to summarize the critical elements of a successful R&D venture with an operational CMI system. The R&D program must have: systematically identified and defined problems which can be prioritized by the research and operational organizations. The problems must have practical proposed solutions within system limitations, and each problem must be supplemented with a feasible research plan. The R&D must have the full cooperative support of both the research and operational organizations. And finally, the research organization must have extensive access to a large variety of "kinds" of specialists including computer and curriculum experts.

II. As an example of what I consider to be a successful CMI R&D program, let me describe the joint venture between the Technical Training Command, which has the instructional responsibility for Navy CMI and the Navy Personnel Research and Development Center which is the R&D arm of the Navy. The PLAN and ACQUIRE phase of the Navy's CMI system were supported by R&D performed in Memphis TN. Located in Memphis were the researchers who developed the instructional model of the CMI system and experimentally tried it out, and the training schools management organization charged with procuring the operational system.

The CMI system that has been acquired and is now in operation is not a sophisticated CAI system. It has the operational requirement of managing the instructional progress of over 7,000 students daily in 9 courses located in 4 geographic locations. The individualized instruction is delivered off-line, mostly by textual materials, and testing is handled primarily with multiple-choice tests with answers entered through optical scanners. The computer scores the tests and provides test feedback and study instructions to the students. Summary

TABLE 3

NAVY CMI R&D PLANNING



data for a student, a learning center, or a school can be obtained from the computer. The instructor is available in the learning center to students who need more tutorial assistance than is provided by the CMI system.

R&D for the IMPLEMENT, EVALUATE, and REFINE phases was preceded by a comprehensive problem identification and research planning effort. The cooperative nature characteristic of the Navy CMI system can be seen by looking at the steps involved in the R&D planning and the parties that particpated in this planning activity. Table 3 shows the successive steps involved in CMI R&D planning along with the types of organizations that participated in each step. A common element in each step is the involvement of the operational schools and management organizations along with the research communities. Following a systematic identification of Navy system problems, other CMI systems, both military and civilian, were examined for possible existing solutions to Navy problems. It was at this point that the Navy realized that there are very few large operational CMI systems in existence which could provide assistance through an exchange of ideas. With the aid of researchers and consultants from the larger world of educational technology, a set of candidate R&D proposals were developed which addressed the Navy CMI system. These proposals were then assessed at a CMI R&D Planning Session held in July 1977 with the purpose of evaluating each proposal in terms of the importance of the problem, the feasibility of the proposed R&D, the extent of the research and human resources necessary for the conduct of the research and the expected implementation costs and benefits if research indicated that a solution should be implemented. At this planning session, school operators, managements of the training command, and military and civilian researchers attempted to arrive at agreement with respect to the proposals.

Since that Planning Session, what is the status of the R&D program? The research community undertook the task of resolving some immediate operational problems. The training command has officially prioritized six of the plans and the research community is now embarking on these R&D efforts. Five of these problems deal with improving the existing CMI system by enhancing or adding capabilities. Since the Navy CMI has already established the computer hardware and software, we must conduct our R&D within the system limitations. That does not mean that new capabilities cannot be added, but merely that solution options must take these limitations into account. The sixth R&D area involves improvement of the Instructor Training program. With any new computer based system it is necessary to redesign the instructor training program to ensure instructor competencies throughout all courses on the system.

Implementation of the R&D outcomes could be a problem in itself. The system change to be implemented must go into all the schools or to all instructors in order to avoid chaos. The change should also be verified as beneficial prior to system-wide implementation. Since a large operational CMI system provides instructional management to a large number of students, the R&D to support the system must not be allowed to interfere with system operational effectiveness.

Although I have only very briefly described the Navy CMI system and its R&D program, perhaps I have conveyed a description of some of the problems that any CMI R&D program will encounter and the general R&D approach which the Navy is using to overcome those problems.